# Chapter 2. North Coast Hydrologic Region

## Setting

The North Coast Region encompasses redwood forests, inland mountain valleys, and the arid Modoc Plateau. The region includes all or large portions of Modoc, Siskiyou, Del Norte, Trinity, Humbolt, Mendocino, Lake, and Sonoma Counties (Figure 2-1). It also includes small areas of Shasta, Tehama, Glenn, Colusa, and Marin Counties. The region extends from Tomales Bay to the Oregon border -- about 400 miles along the Pacific -- then east along the border to just east of Goose Lake. It covers 20,000 square miles, or more than 12 percent of the state. Most of the region is mountainous and rugged. The mountain crests, which form the eastern boundary of the region, are about 6,000 feet elevation with a few peaks higher than 8,000 feet. Only 13 percent of the land is valley or mesa, and more than half of that is in the higher northeastern part of the region in the upper Klamath River Basin.

## Climate

Heavy rainfall makes the region the most water-abundant area of California, producing about 41 percent of the State’s total natural runoff. Annual average precipitation in the region is 53 inches, ranging from more 100 inches in eastern Del Norte County to less than 15 inches in the Lost River drainage area of Modoc County. There is relatively little snow, and it usually stays on the ground only a short time at 4,000 feet and higher.

The average annual runoff is about 29 million acre-feet, or enough water to fill the state's largest reservoir, Shasta Lake, nearly six times.

## Population

The 2000 population was about 644,000. Most urban development is in the Santa Rosa, Ukiah and Eureka areas.

## Land Use

Forest and rangeland represent about 98 percent of the land area of the region. Much of the region is in national forests, state and national parks, and land under the jurisdiction of the Bureau of Land Management and in Indian reservations. The major land uses in the North Coast Region are timber production, agriculture, fish and wildlife propagation, parks, recreation and open space. However, over-cutting of timber and environmental constraints have depressed the timber industry.

Vacationers, boaters, anglers, and sightseers are attracted by the region's 400 miles of scenic ocean shoreline, including nearby forests with more than half of California’s redwoods. Inland there are mountains, including 10 wilderness areas run by the U.S. Forest Service. It has more than 40 state parks, numerous Forest Service campgrounds, the Smith River National Recreation Area and the Redwood National Park. It is an area of rugged natural beauty with some of the most renowned fishing in North America. The various recreation destinations have developed their own small water supplies, including wells, springs and streams.

Climate, soils, water supply, and remoteness from markets limit profitable crops throughout most of the North Coast region. In the inland valley areas, there is more irrigable land than can be irrigated with

existing supplies. The agricultural trend in the past decade has been one of land consolidation and loss of prime agricultural land to urban and slow growth. This reflects the low crop values, lower quality agricultural land, and lack of additional cheap surface water supplies and use of only the most economically developable groundwater sources.

Irrigated agriculture in the North Coast Region uses most of the region's water. Irrigation today accounts for about 81 percent of the region's water use, while municipal and industrial use is only about 19 percent. About 264,500 acres, or about 2 percent of the region, is irrigated. Of that, 225,900 acres are in the Upper Klamath River where the main irrigated crops are pasture and alfalfa, grain, and potatoes. The highest-value crops in the region are the substantial acres of grapes and orchards in the Russian River Basin and ornamental flowers, including bulbs, in Del Norte County.

The acreage of orchards has decreased over the past several decades. For example, in Sonoma County, orchards declined from 20,000 acres in 1971 to fewer than 3,500 in 2001. But irrigation water used on orchards did not decrease in the same proportion because many of the apple, prune and walnut orchards taken out of production were not irrigated. As the acreage orchards declined, vineyard acreage increased. Most new vineyards use drip irrigation systems. Vineyards use overhead sprinklers for frost protection in the spring and for post-harvest irrigation in the fall.

Many of the region's watersheds support listed species of plants and animals, and many North Coast streams and rivers support anadromous fish runs. The principal reaches of the Klamath, Eel, and Smith Rivers have been designated wild and scenic under federal and State law and therefore are protected from additional large-scale water development.

## Water Supply and Use

Communities and rural areas are generally supplied by small local surface and groundwater systems. Larger water supply projects include the Bureau of Reclamation's Klamath Project, the Army Corps of Engineers' Russian River Project, and the Humboldt Bay Municipal Water District's Ruth Reservoir and Eureka to McKinleyville distribution system. Supplies from the largest reservoirs in the region, the Central Valley Project's Trinity Lake and the USCE's Lake Sonoma near Geyserville, were built as export projects to adjacent hydrologic regions. Many groundwater wells rely on hydrologic connection to the rivers and streams of the valleys. Along the coast valleys, most "groundwater" is developed from shallow wells installed in the narrow river terraces adjacent to the river and streams.

The principal uses of environmental water occur in the Lower Klamath, Tule Lake, and Clear Lake National Wildlife Refuges and the Butte Valley and Shasta Valley Wildlife Areas. In Butte Valley, most of the water for wildlife comes from about 3,000 acre-feet of groundwater. Streams, rivers, lakes and reservoirs serve other refuges and wildlife areas in the region.

Through the California Wild and Scenic Rivers Act of 1972, Californians determined that most water in the North Coast Region would remain in the rivers to preserve their free-flowing character and provide for environmental uses. Most of the Eel, Klamath, and Smith Rivers are wild and scenic, which protests their free-flowing pristine character. Additional water may be reallocated to the Trinity, depending on the results of an ongoing 22-year flow evaluation by U.S. Fish and Wildlife Service. A court had ordered an environmental impact report completed by mid-April, 2003. However, issues surrounding the amount of water to be released from the Central Valley Project to the Trinity River remain unresolved.

The following water balance table summarizes the detailed regional water accounting contained in the water portfolio at the end of this regional description. As shown in the table, required ocean outflow is the largest use of water in the region. More water is exported to other regions than is consumptively used in the North Coast Region.

## State of the Region

The North Coast Region generally has good water quality that adequately supports the beneficial uses of its water bodies, including commercial and recreational fishing, shellfish harvesting, and recreation. Many of the region's watersheds preserve listed species of plants and animals, and many North Coast streams and rivers sustain anadromous fish runs. The region features important coastal resources, including Bodega Harbor and Humboldt Bay, as well as small estuaries.

### Challenges

The region nonetheless is confronted by many water quality challenges. The RWQCB's priorities highlight control of nonpoint source runoff from logging, rural roads, agriculture (including grazing), and cities; such runoff causes erosion and sedimentation affecting habitat for spawning and rearing of anadromous fish, or microbial contamination of shellfish (in particular, oyster) growing areas. In fact, sediment, temperature, and nutrients are nearly the sole focus of the region's 303(d) list of impaired water bodies. While water may begin in pristine condition, the region is characterized by rugged, steep, forested lands, with highly erodable, loosely consolidated soils, heavy precipitation, and extensive timber harvesting. Channel modification and water diversions have radically changed water quality conditions in many water bodies in the region. The development of new hillside vineyards is an increasing source of erosion, as well as pesticides. Wildfires and timber salvage, and subsequent erosion, result in sedimentation and landslides.

Fisheries in the region can be adversely affected by a number of water quality factors. The Eel, Mad, and Trinity Rivers, as well as the Garcia River and Redwood Creek, suffer from sedimentation, which can smother salmonid spawning areas. The North Coast Region's basin plan sets turbidity restrictions to control erosion impacts from logging and related activities, such as road building. Timber harvests can also decrease the canopy shading rivers and streams, thereby increasing water temperatures to levels that are detrimental to cold water fisheries. The basin plan also specifically establishes temperature objectives for the Trinity River, in which reduced flows have disrupted temperature and physical cues for anadromous fish runs. Because of water diversions, summer temperatures in the Trinity as well as the Klamath can be lethal to salmonids. Fisheries can be further adversely affected by the lack of woody debris for pool habitat and sediment metering.

The basin plan requires tertiary treatment of wastewater discharges to the Russian River, a major source of domestic water, and establishes limits on bacteriological contamination of shellfish growing areas along the coast. The plan also prohibits or strictly limits waste discharges to the Klamath, Trinity, Smith, Mad, and Eel Rivers, as well as estuaries and other coastal waters. Nonpoint source runoff, especially after precipitation, close shellfish harvesting beds in Humboldt Bay. Stormwater runoff may also be contributing to high ammonia and low dissolved oxygen levels in Laguna de Santa Rosa, threatening aquatic life. Mercury in fish tissue is an issue in Lakes Pillsbury, Mendocino, and Sonoma; a health advisory for mercury has been issued for Lake Pillsbury.

Regional groundwater quality problems include seawater intrusion and nitrates in shallow coastal groundwater aquifers, salinity and alkalinity in the lake sediments of the Modoc Plateau basins, and iron, boron, and manganese in the inland basins of Mendocino and Sonoma counties. Septic tank failures in western Sonoma County, at Monte Rio and Camp Meeker, and along the Trinity below Lewiston Dam, are a concern for recreation water quality. Recreational use of Trinity, Lewiston, and Ruth Lakes present concerns fuel constituents such as MTBE. Abandoned mines, forest herbicide application and historical discharge of wood treatment chemicals at lumber mills, including the Sierra Pacific Industries site near Arcata and Trinity River Lumber Co in Weaverville, are also regional issues of concern. Of note, according to the 305(b) report, only the Russian River basin has a long-term water quality dataset.

Even though the North Coast Region produces a substantial share of California's surface water runoff, only about 10 percent of this runoff occurs in the summer months and water supplies are limited throughout much of the area. Small surface water supply projects generally have limited carryover capacity that cannot supply adequate water during extended months of low rainfall. The drinking water for many of the communities on the North Coast, such as Klamath, Smith River, Crescent City, and most of the Humboldt Bay area, is supplied by Ranney collectors (horizontal wells adjacent to or under the bed of a stream). Erosion is undercutting some of these collectors, such as those in the Mad River supplying the Humboldt Bay Municipal Water District (which serves Eureka, Arcata, and McKinleyville). As such, these "wells" may actually be under the direct influence of surface water, which would require their filtration.

The Russian River provides domestic water to over a half million people, including Santa Rosa and Ukiah, as well as southern Sonoma County and large portions of Marin County. The City of Willits has had chronic problems with turbidity, and taste and odor with water from Morris Reservoir, and high arsenic, iron, and manganese levels in its well supply. Organic chemical contamination have closed municipal wells in the cities of Sebastopol and Santa Rosa. During dry years, seawater intrudes into the domestic water supply wells serving the town of Klamath, which are located along the Klamath River.

The Town of Mendocino typifies the problems related to groundwater development in the shallow marine terrace aquifers; surveys in the mid-1980s indicate that about 10 percent of wells go dry every year and up to 40 percent go dry during drought years.

A significant change in use of the Region's water was approved by the Secretary of the Interior in December, 2000. As part of an effort to restore Trinity River fisheries, the Secretary made a decision to increase Trinity River instream flows from 340,000 acre-feet per year (roughly one quarter of average annual flow at the CVP diversion point on the Trinity River) to an average of 595,000 acre-feet per year. This decision, which would reduce the amount of water available for export from the Trinity River to the Central Valley, is the subject of litigation. Implementation of the new flow regime has been stayed by an injunction pending completion of a Supplemental EIS, scheduled for mid-2004.

The primary water management issue in the Klamath River Basin is the restoration of fish populations that include listed species such as the Lost River and shortnose suckers, Coho salmon and steelhead trout. Studies have not yet shown how to accommodate the needs of both agriculture and fisheries. Some studies indicate that higher water levels in Upper Klamath Lake are an aid to recovery of the two sucker species. The modified operation of the Klamath Project to accommodate the needs of the listed suckers has reduced the river flows that are critical to salmon and steelhead survival in the middle and lower

Klamath. In 2001 during a severe drought, the USBR delivered about 75,000 acre-feet of water to agriculture in California, about 25 percent of the normal supply. In the Tule Lake and Lower Klamath Lake sub basins, this translated to a drought disaster for both agriculture and the wildlife refuges. In 2002, approximately 33,000 adult salmon died trying to swim up the Klamath due to water quality problems. Water supply implications of the Coho and steelhead listings will not be known until management plans are completed and recovery goals are established.

The Eel River complex, the largest river system draining to Humboldt County's coast (and third-largest in California), is plagued by massive sediment loads from unstable soils and heavy rains. Water quality decreases downstream. The Eel River is also host to Humboldt County's largest fisheries. In many streams, adadromous fish are no longer able to reach spawning grounds. Nearly all major waterways are host to anadromous fisheries, particularly Chinook and Coho salmon and cutthroat and steelhead trout, which are adversely affected by water quality and quantity issues.

### Accomplishments

In early 1998 the city of Santa Rosa selected an alternative that would recharge depleted geothermal fields in the Geysers area with treated wastewater as part of its long-term wastewater-recycling program. Under this alternative, the Santa Rosa Subregional Sewage System will pump about 11 million gallons per day of treated wastewater to the Geysers for injection into the steam fields. This amount is a little less than half the flow the treatment system is expected to produce at build out. The project is intended to eliminate weather related problems of the city's disposal system and minimize treated wastewater discharges into the Russian River.

The city of Fort Bragg experienced water shortages during drought years. The water sources for the city are direct diversions from surface water sources. Supplies are inadequate to meet the city's needs during drought years and to maintain instream flows required by DFG. DHS issued an order in 1991 prohibiting new demands on the water system until adequate water supplies were developed. The city has been investigating alternative sources of supply and has implemented water conservation measures and improved existing system capacity. As a result of these corrective measures DHS lifted its order in 1993 and allowed the city to begin issuing building permits, subject to restrictions including no net increase in consumption and implementation of a conservation and retrofit program.

The city of Arcata has robust programs for achieving the dual goals of flood control and habitat enhancement. The city is committed to restoring the natural functioning of urban streams and wetlands. There are numerous city plans that direct the city to pursue the acquisition of conservation easements, deeds to wetland and other land for the re-establishment of a natural flood plain for storm water management and flood control and the restoration of fish and wildlife habitat on Arcata's five urban streams. Within the last ten years, the city has expended millions of dollars towards these ends. Along with city funding there are grants from the California Department of Water Resources, the California Department of Fish and Game, the Wildlife Conservation Board, and the U. S. Fish and Wildlife Service. The city has also collaborated with other government agencies, non-profit organizations, community groups and schools.

The Russian River Action Plan, prepared by Sonoma County Water Agency in 1997, provides a regional assessment of needs in the watershed and identifies fishery habitat restoration projects in need of funding. The SWRCB is promoting a coordinated Russian River fishery restoration plan. In 1997, NMFS listed

steelhead trout as threatened and 2002 listed Coho salmon as endangered along part of the Central California coast that includes the Russian River Basin. SCWA, USACE, and NMFS signed an agreement to establish a framework for consultation under Section 7 of the Endangered Species Act. Under the agreement USACE and SCWA will jointly review information on their respective Russian River activities to determine effects to critical habitat. The Eel-Russian River Commission, composed of county supervisors from Humboldt, Mendocino, and Sonoma Counties (Lake County just left the Commission), provides a regional forum for agencies and groups to stay informed about projects and issues affecting the Eel and Russian Rivers.

## Relationship with Other Regions

The region receives roughly X AF of imported water from the Sacramento River Region and flow from Oregon. The region exports about 800,000 acre-feet annually to the Sacramento River Region.

## Looking to the Future

It is possible that expansion of local water sources will generally be adequate to meet the region's expected municipal and industrial demands over the next 30 years. The Humboldt Bay Municipal Water District system may ultimately expand to serve the Trinidad-Moonstone area which is experiencing local water deficiencies. The Eureka-Arcata area is facing possible construction of a regional water treatment plant and is investigating groundwater development as an alternative source, which would not require treatment.

Crescent City has an adequate supply from the Smith River but needs to increase system transmission and storage capacity and may also be facing construction of a water treatment facility. The city of Rio Dell may also be facing construction of a surface water treatment facility. Ranney wells will be installed in the Eel River as a primary water supply for Rio Dell. Trinity County Waterworks District No. 1, which serves the town of Hayfork from the 800-AF Ewing Reservoir, has plans to enlarge the reservoir and expand its surface water system.

To address the need for greater certainty in project operations, USBR began preparing a long-term Klamath Project operations plan in 1995, but difficult and complex issues have delayed completion of the long-term plan. USBR has issued an annual operations plan each year since 1995 as it continues the development of a long-term plan. The Klamath River Compact Commission is facilitating discussions on management of interstate water resources and plans to promote intergovernmental cooperation on water allocation issues. A few additional wells are expected to augment irrigation supplies in the Butte Valley -- Tule Lake area. Pressure for additional groundwater development in areas like Scott and Shasta Valleys will be greater since the 2002 listing of the Coho salmon. The new listing, along with stricter applications of DFG code regulations will reduce the supplies available for irrigation from existing water developments and from natural runoff.

## Regional Planning

Sonoma County WA is preparing an EIR to develop additional water supply as well as to expand its existing water transmission system. The project will be implemented under an agreement among SCWA and its water contractors. Components of the project include water conservation, increased use of the Russian River Project, and expansion and revised operation of the water transmission system. Water conservation is planned to provide additional saving of 6,600 acre-feet. The Russian River part will allow

for increasing diversions from 75,000 to 101,000 acre-feet from the Russian River. This increase use of the Russian River Project water will require construction of additional diversion and conveyance facilities, including new diversion locations. The project will continue to meet existing instream flow requirements associated with the SWRCB's decision 1610 and will require new water rights applications to SWRCB. The transmission system component has two elements – facilities to divert and treat Russian River Project water and transmission system improvements allowing for delivery of up to 167,000 acre-feet per year. The final EIR was scheduled for late 1998.

The Mendocino Community Services District investigated new water supply sources, including wells in the Big River aquifer and desalting. To date, no acceptable water source has been identified. In 1990, town residents approved developing a public water system if an adequate water source could be found. The district is collecting hydrogeological data on the groundwater basin.

Water from Humboldt Bay Municipal Water District's Ranney collectors in the Mad River has been defined as groundwater under the influence of surface water and must be filtered. A regional filtration plant is estimated to cost $16 million. Accordingly, HBMWD is considering the feasibility of developing groundwater to replace a portion of the Mad River supply and to provide for needed future supplies. In the early 1990s, about 45 MGD of the District's 56 MGD average water use was supplied to the Eureka pulp mills for industrial purposes. This water did not require treatment. Today, if the district turns to the supply that recently was dedicated to the mills, this reallocation of HBMWD supplies will have to be treated, if applied to domestic use.

The Eel-Russian River Commission is exploring possibilities for maintaining or augmenting available water supplies, including construction of additional storage on the upper Eel River and conjunctive use of groundwater with existing surface supplies.

Most Northern California counties lack the resources and funding to assist them with regional or local plans. With continued budget constraints and limited resources, requests for more detailed information, necessary for resolving county, regional and state water issues and concerns will more than likely increase. DWR could assist in providing the needed data and analysis for locals and regional planning.

## Water Portfolios for Water Years 1998, 2000 and 2001

The following tables present actual information about the water supplies and uses for the North Coast hydrologic region. Water year 1998 was a wet year for this region, with annual precipitation at 150 percent of normal, while the statewide annual precipitation was 170 percent of average. Year 2000 represents normal hydrologic conditions with annual precipitation at 100 percent of average for the North Coast region, and year 2001 reflected dryer water year conditions with annual precipitation at 60 percent of average. For comparison, statewide average precipitation in year 2001 was 75 percent of normal. Table 2-1 provides more detailed information about the total water supplies available to this region for these three specific years from precipitation, imports and groundwater, and also summarizes the uses of all of the water supplies. The three Water portfolio tables (Table 2-2) and companion Water Portfolio flow diagrams (Figures 2-2, 2-3 and 2-4) provided more detailed information about how the available water supplies are distributed and used throughout this region.

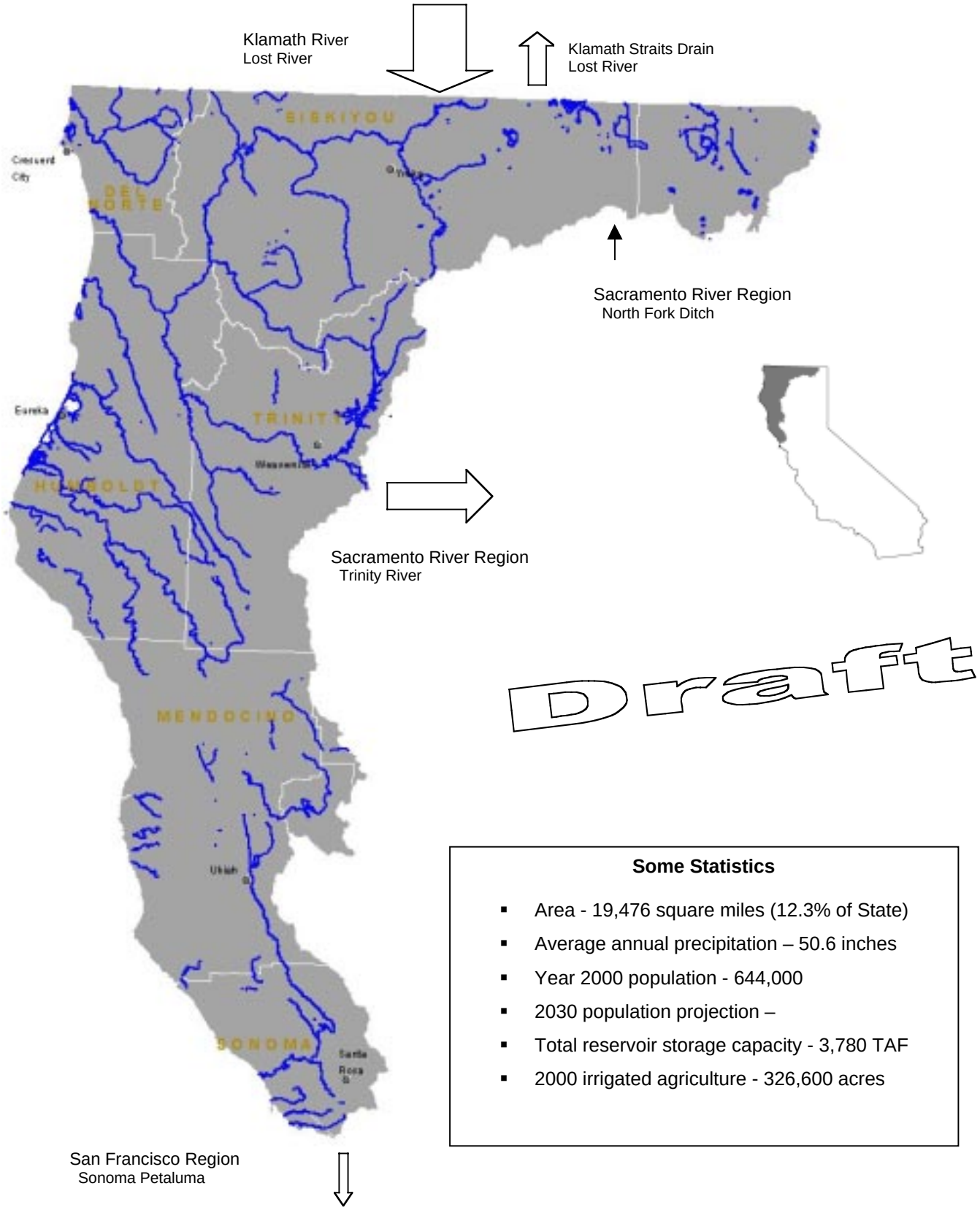
A more detailed tabulation of the portion of the total available water that is dedicated to urban, agricultural and environmental purposes is presented in Table (Table 2-3). Because most of the North

Coast region is largely undeveloped, dedicated environmental water uses are a larger component of the total developed water uses in this region. Table 2-3 also provides detailed information about the sources of the developed water supplies, which are primarily from surface water systems.

### Sources of Information

- Water Quality Control Plan, Regional Water Quality Control Board
- Watershed Management Initiative Chapter, Regional Water Quality Control Board
- 2002 California 305(b) Report on Water Quality, State Water Resources Control Board
- Bulletin 118 (Draft), California's Groundwater, Update 2003, Department of Water Resources
- Nonpoint Source Program Strategy and Implementation Plan, 1998-2013, State Water Resources Control Board, California Coastal Commission, January 2000
- Strategic Plan, State Water Resources Control Board, Regional Water Quality Control Boards, November 15, 2001
- Del Norte, Mendocino, and Siskiyou Counties
- Mendocino County Russian River Flood Control and Water Conservation Improvement District

**Figure 2-1**
**North Coast Hydrologic Region**




**Some Statistics**

- Area - 19,476 square miles (12.3% of State)
- Average annual precipitation – 50.6 inches
- Year 2000 population - 644,000
- 2030 population projection –
- Total reservoir storage capacity - 3,780 TAF
- 2000 irrigated agriculture - 326,600 acres

## Table 2-1
## North Coast Hydrologic Region Water Balance Summary – TAF

Water Entering the Region – Water Leaving the Region = Storage Changes in Region

| | 1998 (wet) | 2000 (average) | 2001 (dry) |
|---|---|---|---|
| **Water Entering the Region** | | | |
| Precipitation | 79,216 | 50,755 | 31,254 |
| Inflow from Oregon | 1,323 | 1,397 | 1,226 |
| Inflow from Colorado River | 0 | 0 | 0 |
| Imports from Other Regions | 2 | 2 | 2 |
| **Total** | **80,541** | **52,174** | **32,482** |
| **Water Leaving the Region** | | | |
| Consumptive Use of Applied Water * (Ag, M&I, Wetlands) | 628 | 796 | 664 |
| Outflow to Oregon | 109 | 114 | 66 |
| Exports to Other Regions | 681 | 669 | 669 |
| Statutory Required Outflow to Salt Sink | 34,715 | 18,763 | 8,021 |
| Additional Outflow to Salt Sink | 110 | 120 | 124 |
| Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows | 43,642 | 31,986 | 23,586 |
| **Total** | **79,885** | **52,448** | **33,130** |
| **Storage Changes in the Region** [+] Water added to storage [–] Water removed from storage | | | |
| Change in Surface Reservoir Storage | 703 | -246 | -491 |
| Change in Groundwater Storage ** | -47 | -28 | -157 |
| **Total** | **656** | **-274** | **-648** |

| | | | |
|---|---|---|---|
| **Applied Water *** (compare with Consumptive Use) | 1,153 | 1,354 | 1,037 |

* Definition - Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

**Footnote for change in Groundwater Storage

Change in Groundwater Storage is based upon best available information. Basins in the north part of the State (North Coast, San Francisco, Sacramento River and North Lahontan Regions and parts of Central Coast and San Joaquin River Regions) have been modeled – spring 1997 to spring 1998 for the 1998 water year and spring 1999 to spring 2000 for the 2000 water year. All other regions and year 2001 were calculated using the following equation:

**GW change in storage =**

**intentional recharge + deep percolation of applied water + conveyance deep percolation - withdrawals**

This equation does not include the unknown factors such as natural recharge and subsurface inflow and outflow.

# Table 2-2
# Water Portfolios for Water Years 1998, 2000 and 2001

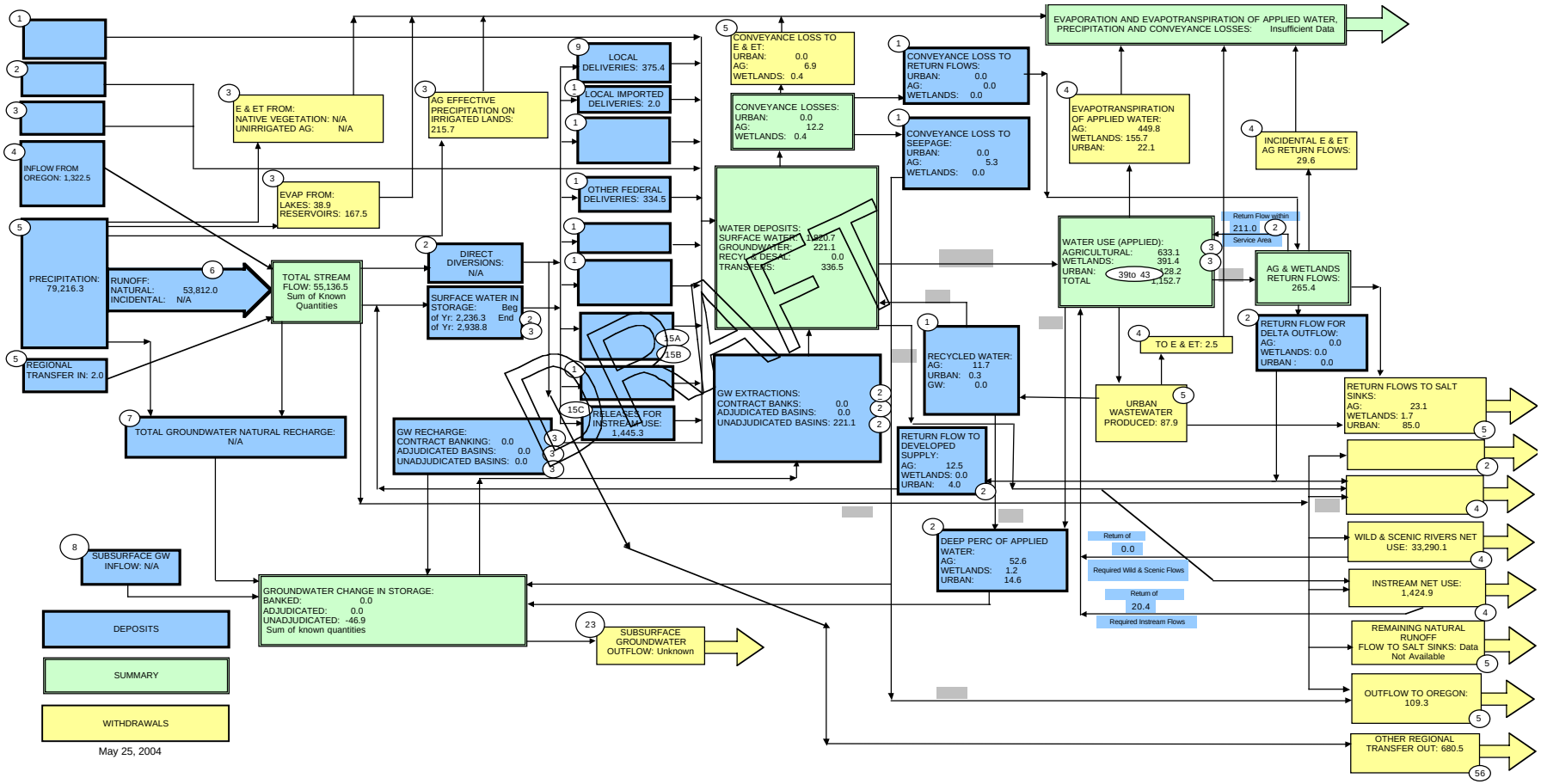
| Category | Description | North Coast 1998 (TAF) | | | | North Coast 2000 (TAF) | | | | North Coast 2001 (TAF) | | | | Data |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inputs:** | | Water Portfolio | Applied Water | Net Water | Depletion | Water Portfolio | Applied Water | Net Water | Depletion | Water Portfolio | Applied Water | Net Water | Depletion | **Detail** |
| 1 | Colorado River Deliveries | | - | | | | - | | | | - | | | PSA/DAU |
| 2 | Total Desalination | | - | | | | - | | | | - | | | PSA/DAU |
| 3 | Water from Refineries | | - | | | | - | | | | - | | | PSA/DAU |
| 4a | Inflow From Oregon | | 1,322.5 | | | | 1,396.7 | | | | 1,226.2 | | | PSA/DAU |
| b | Inflow From Mexico | | - | | | | - | | | | - | | | PSA/DAU |
| 5 | Precipitation | 79,216.3 | | | | 50,755.1 | | | | 31,254.4 | | | | REGION |
| 6a | Runoff - Natural | 53,812.0 | | | | N/A | | | | N/A | | | | REGION |
| b | Runoff - Incidental | N/A | | | | N/A | | | | N/A | | | | REGION |
| 7 | Total Groundwater Natural Recharge | N/A | | | | N/A | | | | N/A | | | | REGION |
| 8 | Groundwater Subsurface Inflow | N/A | | | | N/A | | | | N/A | | | | REGION |
| 9 | Local Deliveries | | 375.4 | | | | 592.4 | | | | 351.1 | | | PSA/DAU |
| 10 | Local Imports | | 2.0 | | | | 3.1 | | | | 16.4 | | | PSA/DAU |
| 11a | Central Valley Project :: Base Deliveries | | - | | | | - | | | | - | | | PSA/DAU |
| b | Central Valley Project :: Project Deliveries | | - | | | | - | | | | - | | | PSA/DAU |
| 12 | Other Federal Deliveries | | 334.5 | | | | 408.7 | | | | 238.2 | | | PSA/DAU |
| 13 | State Water Project Deliveries | | - | | | | - | | | | - | | | PSA/DAU |
| 14a | Water Transfers - Regional | | - | | | | - | | | | - | | | PSA/DAU |
| b | Water Transfers - Imported | | - | | | | - | | | | - | | | PSA/DAU |
| 15a | Releases for Delta Outflow - CVP | | - | | | | - | | | | - | | | REGION |
| b | Releases for Delta Outflow - SWP | | - | | | | - | | | | - | | | REGION |
| c | Instream Flow | | 1,445.3 | | | | 1,444.5 | | | | 1,473.5 | | | REGION |
| 16 | Environmental Water Account Releases | | N/A | | | | N/A | | | | - | | | PSA/DAU |
| 17a | Conveyance Return Flows to Developed Supply - Urban | | - | | | | - | | | | - | | | PSA/DAU |
| b | Conveyance Return Flows to Developed Supply - Ag | | - | | | | - | | | | - | | | PSA/DAU |
| c | Conveyance Return Flows to Developed Supply - Managed Wetla | | - | | | | - | | | | - | | | PSA/DAU |
| 18a | Conveyance Seepage - Urban | | - | | | | - | | | | - | | | PSA/DAU |
| b | Conveyance Seepage - Ag | | 5.3 | | | | 5.4 | | | | 4.9 | | | PSA/DAU |
| c | Conveyance Seepage - Managed Wetlands | | - | | | | - | | | | - | | | PSA/DAU |
| 19a | Recycled Water - Agriculture | | 11.7 | | | | 11.7 | | | | 11.7 | | | PSA/DAU |
| b | Recycled Water - Urban | | 0.3 | | | | 0.3 | | | | 0.4 | | | PSA/DAU |
| c | Recycled Water - Groundwater | | - | | | | - | | | | - | | | PSA/DAU |
| 20a | Return Flow to Developed Supply - Ag | | 12.5 | | | | 6.9 | | | | 6.9 | | | PSA/DAU |
| b | Return Flow to Developed Supply - Wetlands | | - | | | | - | | | | - | | | PSA/DAU |
| c | Return Flow to Developed Supply - Urban | | 4.0 | | | | 3.6 | | | | 3.5 | | | PSA/DAU |
| 21a | Deep Percolation of Applied Water - Ag | | 52.6 | | | | 61.2 | | | | 72.2 | | | PSA/DAU |
| b | Deep Percolation of Applied Water - Wetlands | | 1.2 | | | | 1.3 | | | | 0.7 | | | PSA/DAU |
| c | Deep Percolation of Applied Water - Urban | | 14.6 | | | | 19.4 | | | | 18.6 | | | PSA/DAU |
| 22a | Reuse of Return Flows within Region - Ag | | 67.5 | | | | 86.1 | | | | 23.5 | | | PSA/DAU |
| b | Reuse of Return Flows within Region - Wetlands, Instream, W&S | | 143.5 | | | | 115.5 | | | | 30.3 | | | PSA/DAU |
| 24a | Return Flow for Delta Outflow - Ag | | - | | | | - | | | | - | | | PSA/DAU |
| b | Return Flow for Delta Outflow - Wetlands, Instream, W&S | | - | | | | - | | | | - | | | PSA/DAU |
| c | Return Flow for Delta Outflow - Urban Wastewater | | - | | | | - | | | | - | | | PSA/DAU |
| 25 | Direct Diversions | N/A | | | | N/A | | | | N/A | | | | PSA/DAU |
| 26 | Surface Water in Storage - Beg of Yr | 2,236.3 | | | | 2,740.7 | | | | 2,495.0 | | | | PSA/DAU |
| 27 | Groundwater Extractions - Banked | - | | | | - | | | | - | | | | PSA/DAU |
| 28 | Groundwater Extractions - Adjudicated | - | | | | - | | | | - | | | | PSA/DAU |
| 29 | Groundwater Extractions - Unadjudicated | 221.1 | | | | 335.4 | | | | 462.7 | | | | REGION |
| **Withdrawals:** | **In Thousand Acre-feet** | | | | | | | | | | | | | |
| 23 | Groundwater Subsurface Outflow | N/A | | | | N/A | | | | N/A | | | | REGION |
| 30 | Surface Water Storage - End of Yr | 2,938.8 | | | | 2,495.0 | | | | 2,003.9 | | | | PSA/DAU |
| 31 | Groundwater Recharge-Contract Banking | | - | | | | - | | | | - | | | PSA/DAU |
| 32 | Groundwater Recharge-Adjudicated Basins | | - | | | | - | | | | - | | | PSA/DAU |
| 33 | Groundwater Recharge-Unadjudicated Basins | | - | | | | - | | | | - | | | REGION |
| 34a | Evaporation and Evapotranspiration from Native Vegetation | | | | N/A | | | | N/A | | | | N/A | REGION |
| b | Evaporation and Evapotranspiration from Unirrigated Ag | | | | N/A | | | | N/A | | | | N/A | REGION |
| 35a | Evaporation from Lakes | | | | 38.9 | | | | 45.2 | | | | 42.4 | REGION |
| b | Evaporation from Reservoirs | | | | 167.5 | | | | 181.3 | | | | 162.7 | REGION |
| 36 | Ag Effective Precipitation on Irrigated Lands | | 215.7 | | | | 129.0 | | | | 122.7 | | | REGION |
| 37 | Agricultural Use | | 633.1 | 513.0 | 500.5 | | 785.3 | 638.0 | 631.2 | | 638.4 | 537.7 | 530.8 | PSA/DAU |
| 38 | Wetlands Use | | 391.4 | 267.1 | 267.1 | | 424.4 | 310.2 | 310.2 | | 254.3 | 223.3 | 223.3 | PSA/DAU |
| 39a | Urban Residential Use - Single Family - Interior | | 42.4 | | | | 30.7 | | | | 30.3 | | | PSA/DAU |
| b | Urban Residential Use - Single Family - Exterior | | 19.8 | | | | 40.0 | | | | 42.1 | | | PSA/DAU |
| c | Urban Residential Use - Multi-family - Interior | | 10.9 | | | | 13.8 | | | | 15.0 | | | PSA/DAU |
| d | Urban Residential Use - Multi-family - Exterior | | 2.7 | | | | 3.1 | | | | 3.7 | | | PSA/DAU |
| 40 | Urban Commercial Use | | 20.8 | | | | 16.0 | | | | 17.3 | | | PSA/DAU |
| 41 | Urban Industrial Use | | 26.8 | | | | 27.6 | | | | 27.7 | | | PSA/DAU |
| 42 | Urban Large Landscape | | 4.8 | | | | 12.8 | | | | 13.5 | | | PSA/DAU |
| 43 | Urban Energy Production | | - | | | | - | | | | 0.1 | | | PSA/DAU |
| 44 | Instream Flow | | 1,445.3 | 1,424.9 | 1,424.9 | | 1,444.5 | 1,441.9 | 1,441.9 | | 1,473.5 | 1,473.5 | 1,473.5 | PSA/DAU |
| 45 | Required Delta Outflow | | - | - | - | | - | - | - | | - | - | - | PSA/DAU |
| 46 | Wild & Scenic Rivers Use | | 33,290.1 | 33,290.1 | 33,290.1 | | 17,321.1 | 17,321.1 | 17,321.1 | | 6,547.6 | 6,547.6 | 6,547.6 | PSA/DAU |
| 47a | Evapotranspiration of Applied Water - Ag | | | | 449.8 | | | | 557.8 | | | | 460.6 | PSA/DAU |
| b | Evapotranspiration of Applied Water - Managed Wetlands | | | | 155.7 | | | | 194.4 | | | | 155.3 | PSA/DAU |
| c | Evapotranspiration of Applied Water - Urban | | | | 22.1 | | | | 44.2 | | | | 48.3 | PSA/DAU |
| 48 | Evaporation and Evapotranspiration from Urban Wastewater | | | | 2.5 | | | | 0.2 | | | | 0.2 | REGION |
| 49 | Return Flows Evaporation and Evapotranspiration - Ag | | | | 29.6 | | | | 33.5 | | | | 26.4 | PSA/DAU |
| 50 | Urban Waste Water Produced | 87.9 | | | | 75.6 | | | | 77.7 | | | | REGION |
| 51a | Conveyance Evaporation and Evapotranspiration - Urban | | | | - | | | | - | | | | - | PSA/DAU |
| b | Conveyance Evaporation and Evapotranspiration - Ag | | | | 6.9 | | | | 7.1 | | | | 4.2 | PSA/DAU |
| c | Conveyance Evaporation and Evapotranspiration - Managed Wetlands | | | | 0.4 | | | | 0.4 | | | | 0.1 | PSA/DAU |
| d | Conveyance Loss to Mexico | | | | - | | | | - | | | | - | PSA/DAU |
| 52a | Return Flows to Salt Sink - Ag | | | | 23.1 | | | | 41.9 | | | | 43.8 | PSA/DAU |
| b | Return Flows to Salt Sink - Urban | | | | 85.0 | | | | 76.5 | | | | 79.1 | PSA/DAU |
| c | Return Flows to Salt Sink - Wetlands | | | | 1.7 | | | | 1.7 | | | | 1.5 | PSA/DAU |
| 53 | Remaining Natural Runoff - Flows to Salt Sink | | | | 34,715.0 | | | | 18,763.0 | | | | 8,021.1 | REGION |
| 54a | Outflow to Nevada | | | | - | | | | - | | | | - | REGION |
| b | Outflow to Oregon | | | | 109.3 | | | | 113.7 | | | | 66.4 | REGION |
| c | Outflow to Mexico | | | | - | | | | - | | | | - | REGION |
| 55 | Regional Imports | 2.0 | | | | 2.0 | | | | 2.0 | | | | REGION |
| 56 | Regional Exports | 680.5 | | | | 668.5 | | | | 668.5 | | | | REGION |
| 59 | Groundwater Net Change in Storage | -46.9 | | | | -28.4 | | | | -156.8 | | | | REGION |
| 60 | Surface Water Net Change in Storage | 702.5 | | | | -245.7 | | | | -491.1 | | | | REGION |
| 61 | Surface Water Total Available Storage | 3,779.9 | | | | 3,779.9 | | | | 3,779.9 | | | | REGION |

Colored spaces are where data belongs. N/A - Data Not Available "-" - Data Not Applicable "0" - Null value

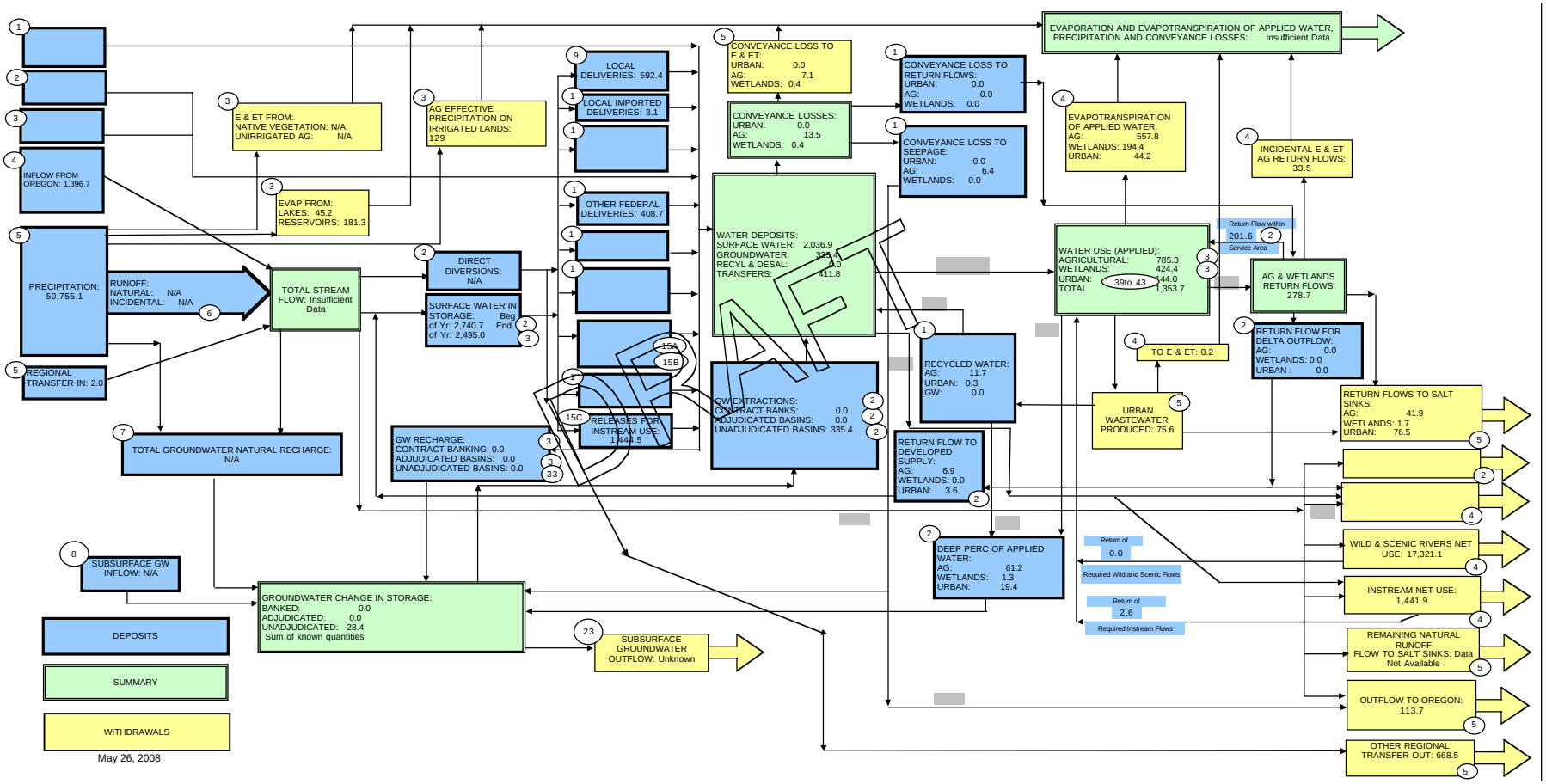
## Table 2-3
## North Coast Hydrologic Region Water Use and Distribution of Dedicated Supplied

| | 1998 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Applied Water Use | Net Water Use | Depletion | Applied Water Use | Net Water Use | Depletion | Applied Water Use | Net Water Use | Depletion |
| **WATER USE** | | | | | | | | | |
| **Urban** | | | | | | | | | |
| Large Landscape | 4.8 | | | 12.8 | | | 13.5 | | |
| Commercial | 20.8 | | | 16.0 | | | 17.3 | | |
| Industrial | 26.8 | | | 27.6 | | | 27.7 | | |
| Energy Production | 0.0 | | | 0.0 | | | 0.1 | | |
| Residential - Interior | 53.3 | | | 44.5 | | | 45.3 | | |
| Residential - Exterior | 22.5 | | | 43.1 | | | 45.8 | | |
| Evapotranspiration of Applied Water | | 22.1 | 22.1 | | 44.2 | 44.2 | | 48.3 | 48.3 |
| Irrecoverable Losses | | 2.5 | 2.5 | | 0.2 | 0.2 | | 0.2 | 0.2 |
| Outflow | | 85.0 | 85.0 | | 76.5 | 76.5 | | 79.1 | 79.1 |
| Conveyance Losses - Applied Water | 0.0 | | | 0.0 | | | 0.0 | | |
| Conveyance Losses - Evaporation | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Conveyance Losses - Irrecoverable Losses | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Conveyance Losses - Outflow | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| GW Recharge Applied Water | 0.0 | | | 0.0 | | | 0.0 | | |
| GW Recharge Evap + Evapotranspiration | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| **Total Urban Use** | **128.2** | **109.6** | **109.6** | **144.0** | **120.9** | **120.9** | **149.7** | **127.6** | **127.6** |
| **Agriculture** | | | | | | | | | |
| On-Farm Applied Water | 633.1 | | | 785.3 | | | 633.4 | | |
| Evapotranspiration of Applied Water | | 449.8 | 449.8 | | 557.8 | 557.8 | | 460.6 | 460.6 |
| Irrecoverable Losses | | 29.6 | 29.6 | | 33.5 | 33.5 | | 26.4 | 26.4 |
| Outflow | | 33.6 | 21.1 | | 46.8 | 39.9 | | 50.7 | 43.8 |
| Conveyance Losses - Applied Water | 24.0 | | | 27.5 | | | 17.9 | | |
| Conveyance Losses - Evaporation | | 6.9 | 6.9 | | 7.1 | 7.1 | | 4.2 | 4.2 |
| Conveyance Losses - Irrecoverable Losses | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Conveyance Losses - Outflow | | 2.0 | 2.0 | | 2.0 | 2.0 | | 0.0 | 0.0 |
| GW Recharge Applied Water | 0.0 | | | 0.0 | | | 0.0 | | |
| GW Recharge Evap + Evapotranspiration | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| **Total Agricultural Use** | **657.1** | **521.9** | **509.4** | **812.8** | **647.2** | **640.3** | **651.3** | **541.9** | **535.0** |
| **Environmental** | | | | | | | | | |
| Instream | | | | | | | | | |
| Applied Water | 1,445.3 | | | 1,444.5 | | | 1,473.5 | | |
| Outflow | | 1,424.9 | 1,424.9 | | 1,441.9 | 1,441.9 | | 1,473.5 | 1,473.5 |
| Wild & Scenic | | | | | | | | | |
| Applied Water | 33,290.1 | | | 17,321.1 | | | 6,547.6 | | |
| Outflow | | 33,290.1 | 33,290.1 | | 17,321.1 | 17,321.1 | | 6,547.6 | 6,547.6 |
| Required Delta Outflow | | | | | | | | | |
| Applied Water | 0.0 | | | 0.0 | | | 0.0 | | |
| Outflow | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Managed Wetlands | | | | | | | | | |
| Habitat Applied Water | 391.4 | | | 424.4 | | | 254.3 | | |
| Evapotranspiration of Applied Water | | 155.7 | 155.7 | | 194.4 | 194.4 | | 155.3 | 155.3 |
| Irrecoverable Losses | | 0.4 | 0.4 | | 0.4 | 0.4 | | 0.1 | 0.1 |
| Outflow | | 111.0 | 111.0 | | 115.4 | 115.4 | | 67.9 | 67.9 |
| Conveyance Losses - Applied Water | 0.0 | | | 0.0 | | | 0.0 | | |
| Conveyance Losses - Evaporation | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Conveyance Losses - Irrecoverable Losses | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Conveyance Losses - Outflow | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Managed Wetlands Use | 391.4 | 267.1 | 267.1 | 424.4 | 310.2 | 310.2 | 254.3 | 223.3 | 223.3 |
| **Total Environmental Use** | **35,126.8** | **34,982.1** | **34,982.1** | **19,190.0** | **19,073.2** | **19,073.2** | **8,275.4** | **8,244.4** | **8,244.4** |
| **TOTAL USE AND LOSSES** | **35,912.1** | **35,613.6** | **35,601.1** | **20,146.8** | **19,841.3** | **19,834.4** | **9,076.4** | **8,913.9** | **8,907.0** |
| **DEDICATED WATER SUPPLIES** | | | | | | | | | |
| **Surface Water** | | | | | | | | | |
| Local Deliveries | 375.4 | 375.4 | 368.8 | 592.4 | 592.4 | 588.3 | 351.1 | 351.1 | 347.1 |
| Local Imported Deliveries | 2.0 | 2.0 | 2.0 | 3.1 | 3.1 | 3.1 | 16.4 | 16.4 | 16.2 |
| Colorado River Deliveries | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CVP Base and Project Deliveries | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Other Federal Deliveries | 334.5 | 334.5 | 328.6 | 408.7 | 408.7 | 405.9 | 238.2 | 238.2 | 235.5 |
| SWP Deliveries | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Required Environmental Instream Flow | 34,746.8 | 34,746.8 | 34,746.8 | 18,583.6 | 18,583.6 | 18,583.6 | 7,933.7 | 7,933.7 | 7,933.7 |
| **Groundwater** | | | | | | | | | |
| Net Withdrawal | 142.9 | 142.9 | 142.9 | 241.5 | 241.5 | 241.5 | 362.4 | 362.4 | 362.4 |
| Artificial Recharge | 0.0 | | | 0.0 | | | 0.0 | | |
| Deep Percolation | 78.2 | | | 93.9 | | | 100.3 | | |
| **Reuse/Recycle** | | | | | | | | | |
| Reuse Surface Water | 220.3 | | | 211.6 | | | 62.2 | | |
| Recycled Water | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.1 | 12.1 | 12.1 |
| **TOTAL SUPPLIES** | **35,912.1** | **35,613.6** | **35,601.1** | **20,146.8** | **19,841.3** | **19,834.4** | **9,076.4** | **8,913.9** | **8,907.0** |
| *Balance = Use - Supplies* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* |

## Figure 2-2
## North Coast Hydrologic Region 1998 Flow Diagram
In Thousand Acre-Feet (TAF)



## Figure 2-3
## North Coast Hydrologic Region 2000 Flow Diagram
In Thousand Acre-Feet (TAF)



## Figure 2-4
## North Coast Hydrologic Region 2001 Flow Diagram
In Thousand Acre-Feet (TAF)